REYNOLDS ALUMINUM

REYNOLDS METALS COMPANY • RICHMOND, VIRGINIA 23261

1980 March 17

Mr. K. P. Bechely
Northern Regional Manager
Field Operation Section
Division of Land/Noise Pollution Control
Illinois Environmental Protection Agency
33 South Stolp Avenue
Aurora, Illinois 60504

Dear Mr. Bechely:

Please find attached the "Hydrogeological Study" prepared for our McCook Sheet & Plate Plant by Woodward-Clyde Consultants. This study inventories existing wells in the vacinity of the McCook Plant plus evaluates in detail the regional and site geology and hydrogeologic conditions. An assessment of existing ground water quality is presented along with an evaluation of the inappropriateness of initiating a ground water monitoring program. Additionally, the estimated costs associated with the installation and operation of a monitoring program for the McCook landfill are presented.

The study clearly demonstrates that installation of ground water monitoring wells would provide little or no useful information on ground water quality due to the area's existing hydrogeologic conditions. Any changes in ground water quality noted in a monitoring program could not conclusively be attributed to the McCook landfill due to the geologic formation in which the site is located. Due to the dewatering activities at the adjacent Material Service Corporation quarry, any potential of ground water discharge from the McCook landfill would discharge into MSC's quarry. Visual inspection of MSC's quarry plus analytical tests performed by Illinois EPA on MSC's ground water discharge shows no appreciable ground water contamination.

Based on the findings of this report we respectfully request that the Illinois Environmental Protection Agency grant our variance request from Rules 303,305(a) and 305(b) of of Chapter 7 of the Illinois Solid Waste Regulations.

If you have any additional questions or need any clarification please feel free to contact me at 804/281-2918.

Sincerely yours,

Charles R. Bent
Staff Environmental Engineer
Environmental Control Department

/plb

Attachment

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Woodward-Clyde Consultants

HYDROGEOLOGICAL STUDY
McCOOK SHEET AND PLATE PLANT LANDFILL

McCOOK, ILLINOIS

Prepared for

Reynolds Metals Company

McCook, Illinois

By

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4 February 1980
Y9C00181

Consulting Engineers, Geologists
and Environmental Scientists

Offices in Other Principal Cities

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1. INTRODUCTION

In accordance with our proposal to Reynolds Metals Company (RMC) dated 21 November 1979, Woodward-Clyde Consultants (WCC) has made a hydrogeological study of the landfill site at the McCook Sheet & Plate Plant. The landfill site is located in an old quarry in the western portion of the plant, approximately 1000 ft south of 47th Street and approximately 4000 ft west of First Avenue in McCook, Illinois.

The study included a review of the McCook operational plan, a review of the existing geological and hydrological conditions in the area, a search of data on existing wells and groundwater quality in the area, and field reconnaissance of the landfill operation at the site and dewatering operation at the adjacent quarry. This report presents the results of the study including an evaluation of the costs associated with the installation and operation of a groundwater monitoring program.

2. BACKGROUND INFORMATION

2.1 Landfill Operation

We have reviewed the McCook Operational Plan (reference 1) describing the landfill operation in the old quarry. We understand that the quarry area is approximately 5½ acres and that the bottom of the quarry is approximately at el 540. On 19 December, in conjunction with a meeting with Mr Buhrmaster, we visited the landfill site and observed the configuration of the quarry and landfill operations. In the meeting, Mr Buhrmaster indicated that Alternate Plan B was accepted by Illinois Environmental Protection Agency, and that deposition from the top of the fill, without compaction or daily cover will continue as the landfill scheme. We understand that the current and future landfill material consists of demolition and construction waste.

The nature of the waste, grading of the site, and steep slopes of the working area promote runoff of water from rainfall and snowmelt. Any infiltration of water through the landfill produces leachate which enters the groundwater system. The nature of the leachate produced is, among other things, a function of the composition and age of the landfill and the rate of infiltration of water.

2.2 Adjacent Quarry Operation

On 28 December, we visited the Material Service Corporation (MSC) quarry adjacent to the RMC landfill site. The RMC landfill shares a common wall with the MSC quarry along its southwest face. Quarrying is currently being done in the main quarry to the south and west of the RMC site. Crushing, grading, and stockpiling are done in a smaller, shallow pit to the north. Locations of the MSC quarry and the RMC landfill site are shown in Figure 1. We obtained information from the quarry office on the current excavation levels within the main quarry, on seepage of water into the quarry, and on the dewatering pumping system.

The current elevation of the greater portion of the quarry floor is approximately at el 409. Deeper areas exist in the southwest corner of the quarry, to el 355. The assistant quarry superintendant indicated that the final bench level over the entire quarry floor will be at el 355.

At the time of our visit, seepage into the quarry was generally coming from the walls on the south, west, and north sides and up from joints in the lower portions of the quarry floor. The northeast wall, which is the common wall directly opposite the RMC landfill site, was not seeping water.

Seepage of water from the walls of the quarry is from horizontal bedding planes in the dolomite rock at various levels. One persistant bedding plane which showed signs of heavy seepage, and was producing water at the time of our visit, was at approximately el 380 to el 390 on the south and west walls. Another bedding plane showing signs of heavy seepage was at approximately el 515 on the north wall towards the northwest corner of the quarry. The northeast wall, the common wall with the RMC site, had stains from old seepage from bedding planes at various levels, but did not show signs of current seepage.

The dewatering system for the quarry consists of a series of collection sumps and retention ponds with pumps and control gates. Main discharge pumps lift the water from the last pond at el 406 to a 36-in.-diameter storm sewer in the northeast portion of the quarry directly opposite the RMC landfill site. We understand from the quarry superintendant that the storm sewer discharges into the Summit-Lyons drainage ditch.

The amount of seepage into the quarry varies with the seasons, being greater during rainy weather and after snowmelt. The capacity of the main ejector pumps is 2000 gal/min. The quarry superintendant indicated that, at times of high seepage, one pump runs continuously throughout the day (the other pump is stand-by in case of breakdown), with the retention ponds almost full to capacity. This indicates that maximum flow into the quarry can be several thousand gallons per minute.

Along the south wall of the quarry near the southeast corner, there are two piles of spoil from dumping from the GMC Electro-Motive Division plant adjacent to the south. The dumping is directly from the top creating piles of spoil in one of the retention ponds of the quarry dewatering system. The quarry superintendant indicated that the spoil is believed to be demolition and construction rubble, but that this has not been verified.

3. WELL INVENTORY

3.1 Sources of Information

We have researched several sources for information for the locations and characteristics of wells within a 3-mile radius of the RMC landfill site. The sources of information researched were:

1. Well files of the Illinois State Geological Survey,
2. Publications of the Illinois State Water Survey and State Geological Survey,
3. Metropolitan Sanitary District of Greater Chicago,
4. Municipalities and agencies in the vicinity, and
5. WCC library and files.

The well files of the State Geological Survey contain reports submitted by well constructors giving data on well locations, dimensions, drilling logs, water levels, and pumping test results, as applicable. Publications of the State Water Survey and State Geological Survey (references 2 and 4) contain summaries of data from many major wells in a wide area around Chicago and evaluate the hydrogeology and groundwater resources of the region. Information from the Metropolitan Sanitary District (MSD) consisted of locations and details of wells for monitoring water quality in the area and test wells for the Deep Tunnel and Reservoir Project. Local municipalities and agencies neighboring the RMC landfill site provided information on their water supply wells, when this information was not available from the other sources. The WCC library and files contained much data on the geology and hydrogeology of the region.

3.2 Existing Wells

Our research revealed records of 92 wells within a 3-mile radius of the RMC landfill site. The records generally consisted of well constructor's reports and water quality monitoring reports. At the time of our inventory, the sources of information contained records of wells constructed in the area from 1908 to the present. For some wells, construction dates were not available.

Pertinent technical data and well details summarized from these records include the following:

1. Date of drilling
2. Owner and intended well use
3. Location by township, range and section plus other descriptive information
4. Total depth of well
5. Depth to top of rock
6. Penetration or thickness of Silurian dolomite in the well
7. Water level depth; static water level at time of drilling or at present, and pumping water level during pumping test or at present pumping rate.
8. Miscellaneous additional information

Ground surface elevations at the wells, when not noted in the records, were taken from the latest U.S. Geological Survey topographic maps of the area (see references 8 and 9). Water level elevations were calculated from the water level depths given in the well records and the ground surface elevations from the USGS maps.

The wells inventoried were grouped into three categories for this study: water supply wells (designated S), monitoring wells (designated MW and AGMW), and test wells (designated TW and I). The data and details of the wells summarized from the well records are presented in Table 1 through Table 3.

Seventy-nine water supply wells (S-1 to S-79) were identified in the area. The water supply wells were installed to provide water to municipal, industrial, and private users. Seventeen of these wells are no longer in use, but the stratigraphy and water level information from the well constructor's reports and drilling logs were used in the hydrogeologic study. Fifty-one of the water supply wells draw water from the Silurian dolomite aquifer and glacial drift.

Seven monitoring wells were identified in the area. Four wells (MW-1 to MW-4) were installed by the Metropolitan Sanitary District (MSD) for obtaining regional water quality data. Three wells (AGMW-6 to AGMW-8) were installed by American Grading Co. to monitor water quality in the vicinity of their sanitary landfill operation. All the monitoring wells are in the Silurian dolomite aquifer.

Six test wells (TW-74-1, TW-74-2, TW-74-3, TW-74-6, TW-74-7, and I-73) were identified in the area. The test wells were installed by MSD to obtain design data and determine aquifer characteristics as part of the Deep Tunnel and Reservoir Project. One well (I-73) penetrates the Cambrian-Ordovician aquifer; the others are in the Silurian dolomite aquifer. Some water quality data was available from the test wells.

The locations of the wells are shown on Figure 1. The well locations were generally plotted in the geometric center of the last quarter section recorded on the well constructor's reports and water quality reports, except where more specific dimensions were given. Other wells for which records were not available may exist within the study area. The State Geological Survey indicates that these wells would be few in number, of minor yield, and most likely be old and abandoned.

4. GEOLOGY AND HYDROGEOLOGY

4.1 Regional Geology

The geology of the Chicago area has been described in detail by several authors. The following discussion is based on the work of Buschbach and Heim (reference 2) and Willman (reference 6).

Most of the Chicago area is covered by soils deposited by several advances of Pleistocene glaciers and high-level stages of Lake Michigan. The glacial drift generally consists of a heterogeneous mixture of sand, gravel, and clay. The lacustrine deposits consist mostly of silt and clay. At the base of the glacial drift, there are extensive deposits of clean sand and gravel.

The bedrock in the Chicago area consists of Silurian dolomite which is about 50 ft to 500 ft thick. The surface of the bedrock is an undulating plain which contains a pattern of stream valleys, in some places more than 100 ft deep. Glacial deposits fill the valleys.

The upper part of the Silurian dolomite, called the Niagaran, is characterized by randomly distributed reefs of pure dolomite surrounded by well layered, silty, interreef dolomite. The lower part of the Silurian dolomite, called the Alexandrian, consists of regularly bedded dolomite units that range from pure to argillaceous or cherty. These are distinctive units that can be traced widely in the area.

Beneath the Silurian rocks are the Ordovician, Cambrian, and Pre-Cambrian systems.

At the top of the Ordovician System in the Chicago area are the Maquoketa shales. A significant unconformity occurs at the top of the shales. As much as 100 ft of shale was removed from some localities before the overlying Silurian rocks were deposited. A minor unconformity also occurs at the base of the shales. Below the Maquoketa shales are the Galena-Platteville dolomites, the upper Galena being medium to thick-bedded dolomite with little limestone, and the lower Platteville being somewhat thinner bedded. The next group below are the Glenwood-St. Peter sandstones. The upper Glenwood sandstone contains some shale and dolomite, while the St. Peter sandstone is clean and generally more porous and permeable. The thickness of the St. Peter is commonly 100 feet to 200 feet in the area, but locally it is more than 400 feet thick where it fills older valleys and sinkholes that have been cut into the underlying surface. At the base of the St. Peter sandstone is a unit of shale and chert rubble that varies from a few inches to over 100 feet thick.

The lowest rocks of the Ordovician System in the area are the sandstones and dolomites of the Prairie du Chien group. In some places these strata were entirely removed by solution and erosion before depositation of the overlying St. Peter sandstone.

Of the rocks in the Cambrian System in the area, the most significant are the Trempealeau-Franconia dolomites, the Ironton-Galesville sandstones, the Eau Claire shales and siltstones, and the Mt. Simon sandstone.

No wells have been drilled to the Pre-Cambrian in this area. Data from wells just outside the area permit inferences concerning the surface of the basement rocks. The top of the Pre-Cambrian is estimated to be from 3000 feet to over 4000 feet below the surface in the Chicago area. Near-by wells that have penetrated the Pre-Cambrian encountered red granite that is about 1.3 billion years old. The topographic surface of the Pre-Cambrian at the beginning of Mt. Simon deposition probably had local relief of several hundred feet.

4.2 Regional Hydrogeology

The groundwater resources of the region have been studied by the State Geological Survey and State Water Survey. The following discussion is based on reports by Prickett et al (reference 4) and Suter et al (reference 5).

Several formations have been defined as sources of groundwater in the region: the glacial drift, the Niagaran-Alexandrian dolomites of the Silurian System, and the sandstones and dolomites of the Cambrian and Ordovician Systems.

The occurence of groundwater in the glacial drift is chiefly in the basal sand and gravel deposits. There are relatively few wells in the glacial drift scattered throughout the area, with only small amounts of water being withdrawn.

The Silurian dolomite is a major aquifer in the area with the majority of the wells fully penetrating its thickness. Groundwater in the Silurian dolomite occurs in joints, fissures, and solution cavities which are irregularly spaced throughout the unit. The upper portion of the Silurian dolomite is highly weathered and fractured. Contact with the overlying glacial drift provides direct rechange from infiltration. Actually the glacial drift and Silurian dolomite can be considered as one aquifer.

Large amounts of groundwater are obtained in areas where the Silurian dolomite contains extensive crevicing. One such area has been identified by the State Water Survey through well constructor's reports and drilling logs to be south of LaGrange from DuPage County east to the Des Plaines River. A large number of high yield wells in the Silurian dolomite exist in this area. The transmissibility of the Silurian dolomite aquifer varies widely due to the irregular fracture system. In this area, an average value of 25,000 gal/day/ft is common. This value represents an average permeability of 3×10^{-3} cm/sec for the thickness of the aquifer in the area.

The Maquoketa shales are generally not a water bearing formation and act as an aquiclude or barrier between the Silurian dolomite and the Cambrian-Ordovician rocks which form the other major aquifer in the area. The average vertical permeability of the Maquoketa shales is reported to be approximately 2×10^{-8} cm/sec (reference 4).

The Galena-Platteville dolomites are at the top of the Cambrian-Ordovician aquifer. These dolomites have only minor crevicing and develop a small amount of water. The Glenwood-St. Peter sandstones are quite porous and contribute about 15% of the water drawn from the Cambrian-Ordovician aquifer. The Prairie du Chien dolomite and upper dolomites of the Cambrian System, the Trempealeau-Franconia, are characterized by irregular crevicing and yield small to moderate amounts of water. The most productive units in the Cambrian-Ordovician aquifer are the Ironton-Galesville sandstones which provide about 80% of its capacity. The Eau Claire shales are generally not water bearing and form the base of the aquifer.

The Mt. Simon sandstone, of Cambrian age, contains coarse, clean portions that are capable of yielding moderate quantities of water. Many deep rock wells in the region are open to the Mt. Simon aquifer as well as the Cambrian-Ordovician aquifer above.

The groundwater regime and direction of groundwater movement in the area was defined by Prickett et al (reference 4) in 1962. Contours of the piezometric surface in the Silurian dolomite were developed from water levels measured in wells. Figure 4 presents the 1962 contours and current available static water elevations measured from 1972 to the present in wells inventoried for this study. There is reasonable agreement between the contours of 1962 and the current data, indicating similar hydrogeologic conditions and rates of pumping. The current groundwater levels in the Silurian dolomite were reported at elevations varying from el 598 to el 570 in the north and west (in wells S-46, MW-1, S-37, and S-35) and from el 546 to el 532 in the south and the east (in wells S-12, TW-74-7, MW-4, and MW-3). Some inconsistancies exist at wells S-38 and S-23. It also appears that the groundwater mound defined by the 1962 contours at Joliet Rd near 47th St no longer exists.

The piezometric contours indicate that the general trend of the groundwater movement in the area is from northwest to southeast. However, significant depressions in the piezometric surface exist around areas of heavy pumping, such as the LaGrange well field, McCook industrial area, and quarries. The groundwater movement in the vicinity of the depressions is locally directed towards the center of the depressions, and does not follow the regional trend.

4.3 Site Geology and Hydrogeologic Conditions

The geology at the RMC landfill site was determined from descriptions of strata reported in the drilling logs of nearby wells and by visual observations during our visits to the landfill site and adjacent quarry. Generalized geologic profiles in the vicinity of the site are presented in Figures 2 and 3.

The soils at the site are glacial drift consisting of a heterogeneous mixture of sand, gravel, and clay. The thickness of the glacial deposits at the site varies from 5 ft to 25 ft.

The Niagaran-Alexandrian dolomites, the major rock strata of concern in this study, are approximately 350 ft thick at the site. The RMC landfill site and the adjacent quarry are entirely within the Silurian dolomite unit. The upper part of the Silurian dolomite is weathered and broken. A system of open vertical joints trending northwest - southeast was observed in the MSC quarry. The spacing of the joints varied from 100 ft to 200 ft.

The groundwater level in the vicinity of the site is highly influenced by the dewatering in the MSC quarry. The water level in the quarry is generally at the level of the floor of the quarry at approximately el 409. The closest wells to the RMC landfill site for which water levels were available are well MW-2, 1000 ft to the north, with a water level at el 540, and well TW-74-1,4000 ft to the south, with a water level at el 443.

The 1962 piezometric contours and current water levels in well MW-2 and the MSC quarry indicate that the RMC landfill is above the zone of saturation and in a localized groundwater discharge zone. The local groundwater gradient beneath the RMC site is approximately 0.1 ft/ft. The regional gradient, based on the 1962 piezometric contours is approximately 0.003 ft/ft.

It is not possible to determine the exact direction and path of the groundwater beneath the site because of the erratic configuration and occurance of joints and solution crevices characteristic of the Silurian dolomite. However, the local joint pattern observed in the MSC quarry indicates that the groundwater flow direction might be from the northeast beneath the site into the southeast corner of the MSC quarry.

Information in the McCook Operational Plan and from our field observations indicate that the permeability of the landfill is probably moderate. The level surface area behind the working face of the landfill seems to be quite impermeable and would promote considerable runoff. Precipitation-infiltration studies of other landfills in the Chicago area show that approximately one-half of the precipitation quantity infiltrates landfills under ordinary conditions. At the RMC landfill, we estimate that somewhat less than half the precipitation will infiltrate the landfill. Under these conditions, a groundwater mound may form within the landfill and the direction of groundwater movement may be changed locally to be in all directions away from the landfill. However, the stronger influence of the cone of depression around the MSC quarry will limit the outward distance leachate from the RMC landfill will migrate before being routed towards the MSC quarry.

5. WATER QUALITY

Laboratory test reports of water quality analyses were available for 26 wells in the vicinity of the RMC landfill site. Most of the analyses were made within the last seven years, with fourteen made in 1978 and 1979. The tests consisted of determination of chemical, physical, and bacteriological characteristics of the groundwater. Table 4 presents the values given in the laboratory reports of concentrations of the various substances and parameters tested.

The laboratory tests on samples from water supply wells were made as part of periodic testing of water quality in municipal and private wells. The laboratory tests on samples from the MSD monitoring and test wells were made to obtain regional water quality data in connection with the Deep Tunnel and Reservoir Project. The laboratory tests on samples from the American Grading Co. monitoring wells were made to monitor the effects of leachate from their sanitary landfill on groundwater quality in the area.

Inspection of the values in Table 4 show that several wells in the area contain concentrations of some substances in excess of those recommended by the Safe Drinking Water Act standards. Generally, the water quality in the area is moderately mineralized, very hard, and contains sufficient iron to cause staining. One well, TW-74-3, was cited in its laboratory report as being contaminated (reference 3).

The closest well to the RMC landfill for which water quality data was available, MW-2, shows that the water is of acceptable quality for drinking . This well is within 1000 ft of the landfill. This fact indicates that, over the years, the RMC landfill operations have not been detrimental to the quality of the water north of the site. Water quality data from wells to the immediate south and west of the site were not available, and there are no wells in the immediate vicinity to the east.

6. ASSESSMENT OF A GROUNDWATER MONITORING PROGRAM

Based on local hydrogeologic conditions, the RMC landfill site is situated in a localized groundwater discharge zone. Leachate produced from infiltration of water through the landfill will in all probability discharge into the southeast corner of the MSC quarry, 200 ft adjacent. There are no water supply wells downgradient between the RMC landfill and the MSC quarry. Migration of leachate some distance in other directions towards existing water supply wells in the vicinity is unlikely due to the influence of the dewatering in the MSC quarry on the direction of groundwater movement.

Due to the irregular distribution of fractures characteristic of the Silurian dolomite, the exact paths of groundwater movement are unknown. Groundwater moving towards and beneath the site, and leachate migrating towards the discharge point in a MSC quarry, will follow an irregular path. Monitoring wells positioned according to a surmised direction of groundwater movement may not intercept the same fracture system as groundwater approaching and leaving the landfill site. Sampling from these wells may not be representative of the quality of the groundwater intended for monitoring. Sampling from existing wells in all directions from the landfill site, and from the dewatering system of the MSC quarry, will probably be more successful in establishing existing background water quality and in noting any changes. The validity of sampling from monitoring wells, however well-placed, may be questionable.

Attenuation of contaminants in a leachate with the distance the leachate migrates is difficult to predict. However, studies indicate that attenuation through jointed rock is very small. In the McCook area, contaminents from distant sources may migrate with little attenuation to wells in the vicinity of the RMC landfill. Attributing changes in groundwater quality noted in a monitoring program solely to the RMC landfill may be questionable.

7.1 GROUNDWATER MONITORING

7.1 Monitoring Program

The minimum requirements for a groundwater monitoring program are defined by the Environmental Protection Agency (reference 7). A groundwater monitoring system would consist of four monitoring wells; one hydraulically upgradient and three hydraulically downgradient from the landfill site. The wells should extend below the lowest predicted groundwater level and have an adequate size collection zone considering the permeability to the stratum from which the water is being sampled.

For purposes of making a cost estimate, we have surmised a typical scheme of monitoring wells and sampling which may be appropriate for the RMC landfill site. Further data and study is needed for actual design of a monitoring program.

In our experience, a 4-in.-diameter borehole with a 3-in.-diameter riser pipe and 10 ft long screened collection zone would be appropriate for monitoring wells in the Silurian dolomite at the landfill site.

The one well upgradient could be positioned by the side of the road entering the landfill site near Plainfield Rd and 47th Street. This location would provide easy access for installation and sampling.

There is insufficient space between the edge of the RMC quarry and the property line to place a drill rig to install the three wells downgradient. These wells might be installed from the bottom of the quarry close to the southwest face, although placing the drill rig in the clear areas at the bottom of the quarry also would present some difficulties. The riser pipes of the monitoring wells would be extended to the ground level. Access to the wells for sampling would require a walkway and guardrail.

As indicated by the groundwater level reported in the closest existing well, MW-2, the elevation of the bottom of the well upgradient would be el 530. Considering the elevation of the water in the adjacent MSC quarry and the thickness of the Silurian dolomite aquifer, the elevations of the bottoms of the three wells downgradient would be el 400, el 360, and el 320.

During the first year of the monitoring program, water samples would be taken from each well on a monthly basis. A comprehensive set of laboratory tests would be required during the first year to determine the chemical, physical, and bacteriological characteristics of the groundwater. During subsequent years, so long as the general nature and operation of the landfill has not changed, at least one sample per year from each well would be required for comprehensive analysis plus an additional number of samples depending on the transmissibility of the aquifer. In the Silurian dolomites, the transmissibility is sufficiently high to require sampling each well every three months. However, the additional samples would undergo less intensive laboratory analyses.

7.2 Estimated Costs

We have made a cost estimate for installation of monitoring wells and performance of a monitoring program as considered above. A breakdown of the costs is presented in Table 5.

Initial fixed costs would include engineering design and inspection of a monitoring program, installation of the wells, construction of a walkway and guardrail, and purchase of a bailer. (It is our experience that bailing the wells, rather than using a pump, to obtain samples is sufficient in this situation and is a common method used in similar monitoring programs). The costs associated with installation of the wells include drilling, screen and riser pipe, sand filter, seal above the collection zone, grout fill, and seal at the ground surface plus labor. We estimate the initial fixed costs to be approximately $23,000. Additional costs might be incurred for placing the drill rig in the bottom of the quarry or on the railroad property at the top.

Costs associated with sampling and testing include technicians to take the samples and ship them to the laboratory, laboratory tests, and administration and reports. We estimate that processing one set of samples from the four wells would cost approximately $4000.

The total costs which would be incurred during the first year for initial fixed costs, frequent sampling, and comprehensive laboratory analyses would be approximately $71,000. For subsequent years, the annual costs for sampling, testing, and maintenance of the wells would be approximately $18,000 per year.

8. CONCLUSIONS AND RECOMMENDATIONS

The geology and hydrogeology in the area of the RMC landfill site has been defined by inventory of wells in the vicinity, site visits, and research of existing publications. The groundwater system which could potentially be affected by the RMC landfill is the Silurian dolomite aquifer. The regional trend of groundwater movement in the Silurian dolomite is from northwest to southeast. A local cone of depression exists in the immediate vicinity of the RMC landfill, primarily due to the dewatering in the adjacent MSC quarry. Migration of groundwater beneath the RMC site follows an irregular pattern of fractures in the rock towards a discharge point in the MSC quarry. There is little concern that any potential leachate from the RMC landfill will contaminate neighboring water supply wells because none exist between the RMC landfill and the discharge point of the leachate in the adjacent MSC quarry.

The validity of conclusions which may be drawn from data obtained from a groundwater monitoring program initiated at the RMC landfill may be questionable in the following respects:

1) Due to the irregular distribution of fractures in the Silurian dolomite, exact pathways of groundwater movement are unknown. Monitoring wells may not encounter the same fracture system as groundwater moving towards the site and any potential leachate leaving the site.

2) Contaminents in leachate from other sources may undergo little attenuation during migration through fractures in the Silurian dolomite aquifer. Attributing all changes in groundwater quality detected in a monitoring program to the RMC landfill would be questionable.

REFERENCES

1. Andrews J. D., "On-site Disposal Area Plan" for Reynolds Metals Co., McCook, Illinois, undated.

2. Buschbach T. C. and Heim G. E. "Preliminary Geologic Investigations of Rock Tunnel Sites for Flood and Pollution Control in the Greater Chicago Area" Environmental Geology Notes Number 52, Illinois State Geological Survey, May 1972.

3. Illinois State Water Survey, letter from Northern Regional Office to Metropolitan Sanitary District of Greater Chicago, dated 20 August 1975.

4. Prickett, et al "Groundwater Development in Several Areas of Northeastern Illinois" Report of Investigation 47, Illinois State Water Survey, 1964.

5. Suter, et al, Preliminary Report, "Groundwater Resources at the Chicago Region, Illinois" Cooperative Groundwater Report 1, Illinois State Water Survey and State Geological Survey, 1959.

6. Willman, H. B. "Summary of the Geology of the Chicago Area" Circular 460, Illinois State Geological Survey, 1971.

7. ____ "Hazardous Waste - Proposed Guidelines and Regulations and Proposal on Identification and Listing" Environmental Protection Agency, Federal Register, Monday 18 December 1978, Part IV.

8. ____ "Berwyn, Illinois Quadrangle" USGS Topographic Map, 7.5 Minute Series, 1963 (photorevised 1972).

9. ____ "Hinsdale, Illinois Quadrangle", USGS Topographic Map, 7.5 Minute Series, 1963 (photorevised 1972).

TABLE I

DATA SUMMARIZED FROM WELL RECORDS FOR WATER SUPPLY WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
S-1 1929	Lyon City, Municipal	38/12/1	620	2020 C-O (1)	0	355 1929	470 S (2) -300 P	
S-2	Lyon City, Municipal	38/12/1	—	1980 C-O	20	320	—	Abandoned
S-3 1968	MSD	38/12/3 SW, SW, SW	—	393 SD	0	371	—	
S-4 1950	Glen Shiley, Private	38/12/9 365' North 2450' East of SW	649	330 SD	40	210	—	
S-5 1937	GMC Electro-Motive, Industrial	38/12/10 Center W½ of NW, SW	639	1989 C-O	23	387	356 S 259 P	Abandoned
S-6 1935	GMC Electro-Motive, Industrial	38/12/10	—	1590 C-O	20	270	—	Abandoned 1956
S-7 1943	Lewis Tar Products, Industrial	38/12/11 1800' South 1900' West of NE	607	1172 C-O	10	350	—	Abandoned 1958
S-8 1939	Universal Oil Company, Industrial	38/12/11	610	1564 C-O	4	349	571 1939	
S-9 1968	S. A. Healy & Company	38/12/12 600' South 200' West of NE, SW	600	200 SD	51	149	570 S 555 P 1968	
S-10 1914	City of Summit, Municipal	38/12/12 200' North 1850' West of SE	—	1870 C-O	58	280	—	Abandoned 1938
S-11 1908	City of Summit, Municipal	38/12/12	—	1547 C-O	56	280	—	Abandoned 1938
S-12 1975	Harold Tummons, Private	38/12/13	600	225 SD	84	141	546 1975	
S-13 1974	Vulcan Materials, Industrial	38/12/15 300' North 1500' East of SW c SE	—	380 SD	0	380	—	
S-14 1949	UAW-CIO	38/12/16 100' South 100' West of NE	647	360 SD	20	340	—	
S-15 1958	Robert Hall Clothing Store	38/12/16 NW, SW, NE	650	217 SD	36	181	565 1958	
S-16 1958	Oklahoma Gas Company, Industrial	38/12/16	651	230 SD	35	195	565 1958	
S-17 1961	Riverside Sales Corp.	38/12/16 1800' West 0' North of SW	—	359 SD	52	300	—	
S-18 1954	Southwind Motel	38/12/16	—	325 SD	34	291	—	Abandoned 1960

TABLE 1 (CONTINUED)

DATA SUMMARIZED FROM WELL RECORDS FOR WATER SUPPLY WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
S-19 1949	UAW-CIO	38/12/16 100' South 100' West of NE	—	361	28	333	—	
S-20 1973	MSD Barge Loading Facility	38/12/22 200' North 431' East of SW, SW, SE	—	260 SD	32	228	—	
S-21 1974	Material Service Corp. Yard #18	38/12/2	—	209 SD	—	—	—	
S-22	Werner Mfg. Co., Industrial	38/12/2	—	385 SD	—	—	—	Abandoned
S-23	Cook County Forest Preserve	38/12/12	590	115 SD	—	—	575 1979	Hand Pump
S-24	Cook County Forest Preserve	38/12/1	—	65 GD	—	—	—	Hand Pump
S-25	Cook County Forest Preserve	38/12/1	600	178 SD	—	—	568	Hand Pump
S-26 1917	Corn Products Refining Co., Industrial	38/12/23 929' South 1218' West of NE	—	1530 C-O	60	280	—	Abandoned
S-27 1917	Corn Products Refining Co., Industrial	38/12/23 405' South 1010' West of NE	—	1879 C-O	38	310	—	Abandoned
S-28 1917	Corn Products Refining Co., Industrial	38/12/23 40' South 270' West of NE	—	1874 C-O	40	307	—	Abandoned
S-29 1917	Corn Products Refining Co., Industrial	38/12/23 1190' South 230' West of NE	—	1863 C-O	46	329	—	Abandoned
S-30 1917	Corn Products Refining Co., Industrial	38/12/23 —	—	1491 C-O	64	281	—	Abandoned
S-31 1917	Corn Products Refining Co., Industrial	38/12/23 —	—	1638 C-O	29	333	—	Abandoned
S-32 1951	Plainview School District #106, Municipal	38/12/17 1700' West 2500' South of SW c SW	605	390 SD	60	315	—	
S-33	Plainview School District #106, Municipal	38/12/17	605	212 SD	37	—	—	
S-34 1952	Midwest Water Co.	38/12/17 425' North 500' West of SE	—	375 SD	60	315	—	
S-35 1964	LaGrange Highlands Sanitary District, Municipal	38/12/17	691	412 SD	75	215	516 P 1979 591 S 499 P	
S-36 1953	Edgewood Park Utilities	38/12/17 SW, NW, SE	—	420 SD	54	351	—	Abandoned 1967

TABLE I (CONTINUED)

DATA SUMMARIZED FROM WELL RECORDS FOR WATER SUPPLY WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
S-37 1965	LaGrange Highlands Sanitary District, Municipal	38/12/7 750' South 250' West of NE	677	420 SD	47	361	487 P 1979 570 S 512 P	
S-38 1965	LaGrange Highlands Sanitary District, Municipal	38/12/17 1470' North 225' West of NW	678	411 SD	56	339	504 P 1979 556 S 519 P	
S-39 1968	MSD	38/12/17 SW, SW, NW	—	847 C-O	40	225	—	
S-40 1937	GMC, Industrial	38/12/10 2000' North 100' West of SW	647	1989 C-O	24	362	392 S 267 P	Abandoned 1956
S-41 1937	Chicago Zoological Society	39/12/35	—	2061 C-O	7	355	—	
S-42 1942	CPC International Inc.; Industrial	38/12/23	595	1543 C-O	25	315	—	
S-43 1947	LaGrange City, Municipal	38/12/5 Gilbert & Cossitt	660	358 SD	—	—	576 1962 450 S 382 P	
S-44 1949	LaGrange City, Municipal	38/12/5 Edgewood & Cossitt	650	352 SD	—	—	420 S 376 P	
S-45 1964	LaGrange City, Municipal	38/12/5 Brainard & Burlington R.R.	645	361 SD	—	—	411 S 366 P	
S-46	LaGrange Park, Municipal	39/12/33	625	370 SD	—	—	598 1962	
S-47	Our Lady Of Bethelem Academy	39/12/32	635	465 SD	—	—	600 1962	
S-48	Cook County Forest Preserve	39/12/35	613	100 SD	—	—	591 1962	
S-49	Cook County Forest Preserve	39/12/26	621	180 SD	—	—	602 1962	
S-50 1928	Public Service Company, Municipal	38/12/4 1150' West 2800 North of SE Corner	629	2008 C-O	—	—	—	
S-51 1926	Nazareth Academy High School, Private	38/12/5	642	1902 C-O	—	—	—	
S-52 1950	LaGrange Park, Municipal	38/12/5	650	203 SD	—	—	—	
S-53 1924	City of Western Springs, Municipal	38/12/5	671	385 SD	—	—	—	
S-54 1923	City of Western Springs, Municipal	38/12/5	671	385 SD	—	—	—	

TABLE I (CONTINUED)

DATA SUMMARIZED FROM WELL RECORDS FOR WATER SUPPLY WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
S-55 1935	GMC, Industrial	38/12/10	620	1590 C-O	—	—	—	
S-56	MSD	38/12/9 1f	—	355 SD	—	—	—	Abandoned 197?
S-57	—	38/12/11 6c	—	365 SD	10	355	—	
S-58	—	38/12/17 6d	—	393 SD	81	312	—	
S-59	—	38/12/12 3e	—	2072 C-O	70	395	—	
S-60	—	39/12/34 8a	—	39 GD	33	6	—	
S-61	—	39/12/35 4e	—	22 GD	22	1	—	
S-62	Cook County Forest Preserve	38/12/2 5f	612	200 SD	—	—	439 1963	
S-63	Culligan Soft Water Service	38/12/3 2g	618	340 SD	—	—	510 1962	
S-64	Willow Farms Production	38/12/3 3a	625	365 SD	—	—	436 1962	
S-65	Hi-way Restaurant, Private	38/12/4 4h	645	250 SD	—	—	600 1962	
S-66	LaGrange City, Municipal	38/12/4 8d	649	459 SD	—	—	569 1962	
S-67 1908	LaGrange City, Municipal	38/12/4 8c Elm & Brainard	646	475 SD	—	—	544 1962	Plugged 1951, Used irregularl; Water quality tested 1978
S-68	LaGrange Country Club	38/12/8 1a	670	370 SD	—	—	560 1962	
S-69	LaGrange Country Club	38/12/8 1d	655	356 SD	—	—	533 1962	
S-70	Material Service Corporation Quarry	38/12/10 7g	—	—	—	—	462 1963	
S-71	Rte 66 Car Wash	38/12/11 1h	611	300 SD	—	—	598 1962	
S-72	Consumer Quarry	38/12/15 1f	—	—	—	—	394 1963	
S-73	Dolese & Shepard Quarry	38/12/15 5b	—	—	—	—	497 1963	
S-74 1955	LaGrange Field Club	38/12/8 3h	—	333 SD	—	—	—	
S-75 1950	Mark Magisano, Private	38/12/9 8d	—	327 SD	—	—	—	

TABLE I (CONTINUED)

DATA SUMMARIZED FROM WELL RECORDS FOR WATER SUPPLY WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
S-76 1951	School District #105	38/12/16 4c	—	377 SD	—	—	—	
S-77 1954	Finn Construction Company	38/12/16 8e	—	325 SD	—	—	—	
S-78 1959	E. G. Boone	38/12/18 1h	—	190 SD	—	—	—	
S-79 —	LaGrange Park, Municipal	39/12/33 29	625	370 SD	—	—	598 1962	

NOTES

(1) GD indicates glacial drift aquifer.
SD indicates Silurian dolomite aquifer.
C-O indicates Cambrian-Ordovician aquifer.

(2) S indicates static water level.
P indicates pumping water level.

TABLE 2

DATA SUMMARIZED FROM WELL RECORDS FOR MONITORING WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
MW-1 1974	MSD, Monitoring Well	38/12/4	—	206 SD	—	—	586 1979	
MW-2 1974	MSD, Monitoring Well	38/12/10 105' South 2500' West of NE	—	206 SD	—	—	540 1979	
MW-3 1974	MSD, Monitoring Well	38/12/2 1600' West 50' North of SE	615	210 SD	45	—	532 1979	
MW-4	MSD, Monitoring Well	38/12/12 NW, NW, NW	—	—	—	—	539 1979	
AGMW-6	American Grading Co., Monitoring Well	38/12/4	—	—	—	—	—	Only water quality data available
AGWM-7	American Grading Co., Monitoring Well	38/12/14	—	—	—	—	—	Only water quality data available
AGMW-8	American Grading Co., Monitoring Well	38/12/14	—	—	—	—	—	Only water quality data available

TABLE 3

DATA SUMMARIZED FROM WELL RECORDS FOR TEST WELLS

WELL NUMBER AND DATE OF DRILLING	OWNER AND INTENDED USE	LOCATION (Twp/Rge/Sec)	GROUND SURFACE ELEVATION (ft)	WELL DEPTH (ft) AND AQUIFER	DEPTH TO ROCK (ft)	PENETRATION OF SILURIAN DOLOMITE IN WELL (ft)	WATER LEVEL ELEVATION AND DATE	REMARKS
TW-74-1 1974	MSD, Test Well	38/12/10 1000' East 350' North of SW	646	430 SD	34	351	443 S 408 P	
TW-74-2 1974	MSD, Test Well	38/12/21 2600' South 1300" West of NE	—	385 SD	—	—	609 1979	
TW-74-3 1974	MSD, Test Well	38/12/11 100' North 100' West of SE c NE, SE, SW	607	390 SD	8	307	542 1974 528 S 439 P	
TW-74 -6 1974	MSD Test Well	38/12/15 500' North 400' East of SW c SW, SE, SE	600	390 SD	43	285	556 S 449 P	
TW-74-7 1974	MSD, Test Well	38/12/12 1121' South 70' East of NW, NW, NW, NW	608	211 SD	66	146	533 S	
I-73 1973	MSD, Test Well	38/12/12 1800' North 2100 East of SW	—	1193 C-O	40	288	—	

TABLE 4
SUMMARY OF WATER QUALITY ANALYSES

WELL NUMBER AND DATE OF SAMPLING

SUBSTANCE	S-4 1973	S-20 1973	S-21 1973	S-22 1973	S-23 1973	S-24 1973	S-25 1973	S-34 1958	S-35 1978	S-36 1958	S-37 1978	S-38 1978	S-41 1969	S-43 1978	S-44 1978	S-45 1978	S-45a 1978	S-67 1978	MW-1 1979	MW-2 1979	MW-3 1979	MW-4 1979	AGMW-6 1979	AGMW-7 1979	TW-74-1 1974	TW-74-3 1974
Arsenic	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.00	0.00	0.00	< 0.001	—	—	—	—	—	—	—	—
Copper	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.07	0.01	0.02	0.10	< 0.14	—	—	—	—	—	—	—	0.034
Cyanide	—	—	—	—	—	—	—	—	0.00	—	0.00	0.02	—	—	0.00	—	0.00	< 0.005	0.000	0.001	0.000	0.000	—	—	—	0.032
Iron	tr	0.4	0.0	tr	0.7	0.4	2.8	0.9	1.0	2.7	1.0	1.3	0.2	1.99	1.54	1.13	0.1	0.83	—	—	—	—	0.9	29.0	1.1	1.6
Mercury (ppb)	—	—	—	—	—	—	—	—	0.05	—	0.11	< 0.03	—	< 0.04	< 0.03	< 0.03	0.03	< 0.03	< 0.1	< 0.1	0.2	< 0.1	—	—	—	0.50
Manganese	—	0.01	—	—	—	—	—	0.0	0.46	—	0.04	0.04	—	0.08	0.08	0.04	0.04	0.07	—	—	—	—	—	—	—	0.06
Sodium	—	—	—	—	—	—	—	99	88	—	96	109	292	73	71	61	480	250	—	—	—	—	—	—	—	534
Barium	—	—	—	—	—	—	—	—	0.2	—	0.5	0.2	—	0.0	0.0	0.0	0.0	0.1	—	—	—	—	—	—	—	—
Cadmium	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.00	0.00	0.00	< 0.0005	—	—	—	—	—	—	—	—
Chromium	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.03	0.00	0.00	< 0.005	—	—	—	—	—	—	—	0.02
Lead	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.01	0.00	0.00	0.014	—	—	—	—	—	—	—	0.19
Selenium	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.00	0.00	0.00	< 0.001	—	—	—	—	—	—	—	—
Silver	—	—	—	—	—	—	—	—	0.00	—	0.00	0.00	—	0.00	0.00	0.00	0.00	< 0.005	—	—	—	—	—	—	—	—
Zinc	—	—	—	—	—	—	—	—	0.00	—	0.1	0.1	—	0.13	0.05	0.08	0.0	0.06	—	—	—	—	—	—	—	—
Magnesium	—	—	—	—	—	—	—	34	82	—	90	100	—	84	90	94	24	125	—	—	—	—	—	—	—	95.5
Calcium	—	—	—	—	—	—	—	158	190	—	190	220	—	210	210	190	25	180	—	—	—	—	—	—	—	167
Potassium	—	—	—	—	—	—	—	—	5.9	—	6.1	5.4	—	5.1	6.3	4.6	5.1	12	—	—	—	—	—	—	—	194
Nickel	—	—	—	—	—	—	—	—	0.0	—	0.0	0.0	—	0.0	0.0	0.0	0.0	< 0.05	—	—	—	—	—	—	—	—
Boron	—	—	—	—	—	—	—	0.2	0.3	0.1	0.3	0.3	—	0.3	0.3	0.3	0.2	0.3	—	—	—	—	0.5	0.7	—	—
Phosphorous	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.05	0.02	0.04	—	—	—	2.46
Ammonia Nitrogen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	157
Total Nitrogen	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	217.6
Silica	—	—	—	—	—	—	—	12.4	12	—	13	13	—	13	13	13	13	12	—	—	—	—	—	—	—	—
Chloride	55	18	90	75	37	6	7	20	150	21	175	265	315	135	120	115	250	445	126	196	87	74	230	1800	75	496
Fluoride	—	0.5	—	—	—	—	—	0.1	0.4	0.1	0.4	0.3	2.5	0.3	0.3	0.4	1.1	0.2	—	—	—	—	—	—	—	—
Ammonium	tr	—	0.0	0.5	0.4	tr	0.3	tr	0.8	—	0.8	0.6	—	0.8	0.6	0.5	0.5	0.3	0.7	1.0	0.4	0.5	—	—	tr	—
Nitrate	1.6	1.2	3.3	1.8	1.1	1.4	1.0	1.0	0.0	—	0.0	0.0	3.6	0.0	0.4	0.0	0.0	< 0.4	—	—	—	—	—	—	0.5	0.600
Nitrite	0.0	—	0.02	0.09	0.01	0.01	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.03	0.150
Sulphate	—	—	—	—	—	—	—	326	390	—	400	435	67.5	440	470	430	440	470	—	—	—	—	—	—	—	800
Phosphate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.0	1.9
Surfactant	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.20
Phenol	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0	0	0	0	—	—	—	0.005
pH	7.05	—	7.50	7.15	7.15	7.45	7.35	—	7.1	—	7.2	7.1	—	7.1	6.8	6.7	7.8	7.1	7.1	7.3	7.7	7.4	—	—	7.7	7.6
Residue on Evaporation	878	—	1028	875	881	417	475	—	1260	—	1282	1360	—	1250	1330	1300	1380	1780	—	—	—	—	1300	4400	924	—
Total Suspended Solids	—	—	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	66	11	16	—	—	—	9
Volatile Suspn'd Solids	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Total Dissolved Solids	762	666	918	765	735	379	410	882	960	1146	1000	1100	997	950	980	930	1270	1650	—	—	—	—	—	—	823	2664
Hardness	670	502	670	610	600	334	350	536	850	810	850	968	218	886	968	908	156	994	—	—	—	—	—	—	710	572
Alkalinity	396	358	340	340	300	280	260	384	369	372	380	382	336	370	391	389	379	391	348	331	317	382	—	—	340	2010
Conductance (mmhos/cm)	—	—	—	—	—	—	—	—	1600	—	1670	1830	—	1590	1630	1550	2110	2750	1200	1380	1100	1280	—	—	0.0	4000
Turbidity	0	9	0	0	2	1	16	4	—	5	—	—	1	—	—	—	—	—	—	—	—	—	—	—	35	45
Color	0	0	0	0	5	0	0	0	—	0	—	3000	0	—	—	—	—	—	—	—	—	—	—	—	0	—
Odor	0	0	0	0	0	0	0	0	—	0	—	—	0	—	—	—	—	—	—	—	—	—	—	—	0	—
Temp. °F	58.5	—	52.5	56.0	51.0	50.0	48.5	52	—	51.8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Biological Oxygen Demand	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	3	1	0	—	—	—	23
Chemical Oxygen Demand	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	4	2	—	—	—	527
Total Plate Count	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.3×10^5	6×10^4	2.2×10^5	4×10^5	—	—	—	—
Total Coliform	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 1	< 1	< 1	< 1	—	—	—	19000
Fecal Coliform	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 1	< 1	< 1	< 1	—	—	—	10
Fecal Streptococci	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	< 1	< 1	2	< 1	—	—	—	10

TABLE 5
ESTIMATED COSTS FOR GROUNDWATER MONITORING PROGRAM

1. Initial Fixed Costs

1a. Installation of Wells

Item	Quantity		Unit Price	Cost
Drilling	Upgradient well el 630 to el 530 Downgradient wells el 540 to el 400, el 360, el 320 Total Drilling Footage	 = 100 ft = 540 ft 640 ft	$ 15.	$ 9600.
Slotted Screen	4 wells x 10 ft = 40 ft		11.	440.
Riser Pipe	640 + (3 x 100) - screen = 900 ft		2.	1800.
Sand Filter	4 wells x 2 bags = 8 bags sand		5.	40.
Collection Zone Seal	2 boxes bentonite balls		25.	50.
Grout Fill	6 bags cement + 6 bags bentonite = 12 bags		5.	60.
Surface Seal	4 bags cement		5.	20.
Labor (rig and crew)	16 hrs		70.	1120.
			Total Installation	$13030.

1b. Engineering Design and Inspection		4000.
1c. Construction of Walkway		3000.
1d. Bailer		300.
	Subtotal	$20430.
1e. Administration, 10%		2043.
	Total Initial Fixed Costs, say	$23000.

2. Sampling and Testing

2a. Take one set of samples from each well		2 men, 1 day	$ 500.
2b. Ship samples to laboratory			100.
2c. Laboratory tests			
Standard tests for drinking water	$305.		
Extra tests as per EPA rules	$352.		
	$657.	x 4 wells	2628.
		Subtotal	$ 3278. per set
2d. Administration and Reports, 20%			656.
		Total Sampling and Testing, say	$ 4000. per set

SUMMARY

1. Costs Incurred First Year		
Total initial fixed costs		$23000.
Sampling and testing, one set per month	12 x $4000.	48000.
	Total Costs First Year	$71000.
2. Costs In Subsequent Years		
Comprehensive analysis	1 set x $4000.	$ 4000.
Minimum analysis	3 sets x $3700.	11100.
Maintenance, 10% of initial cost		2300.
	Total Costs Subsequent Years	$17400. per year

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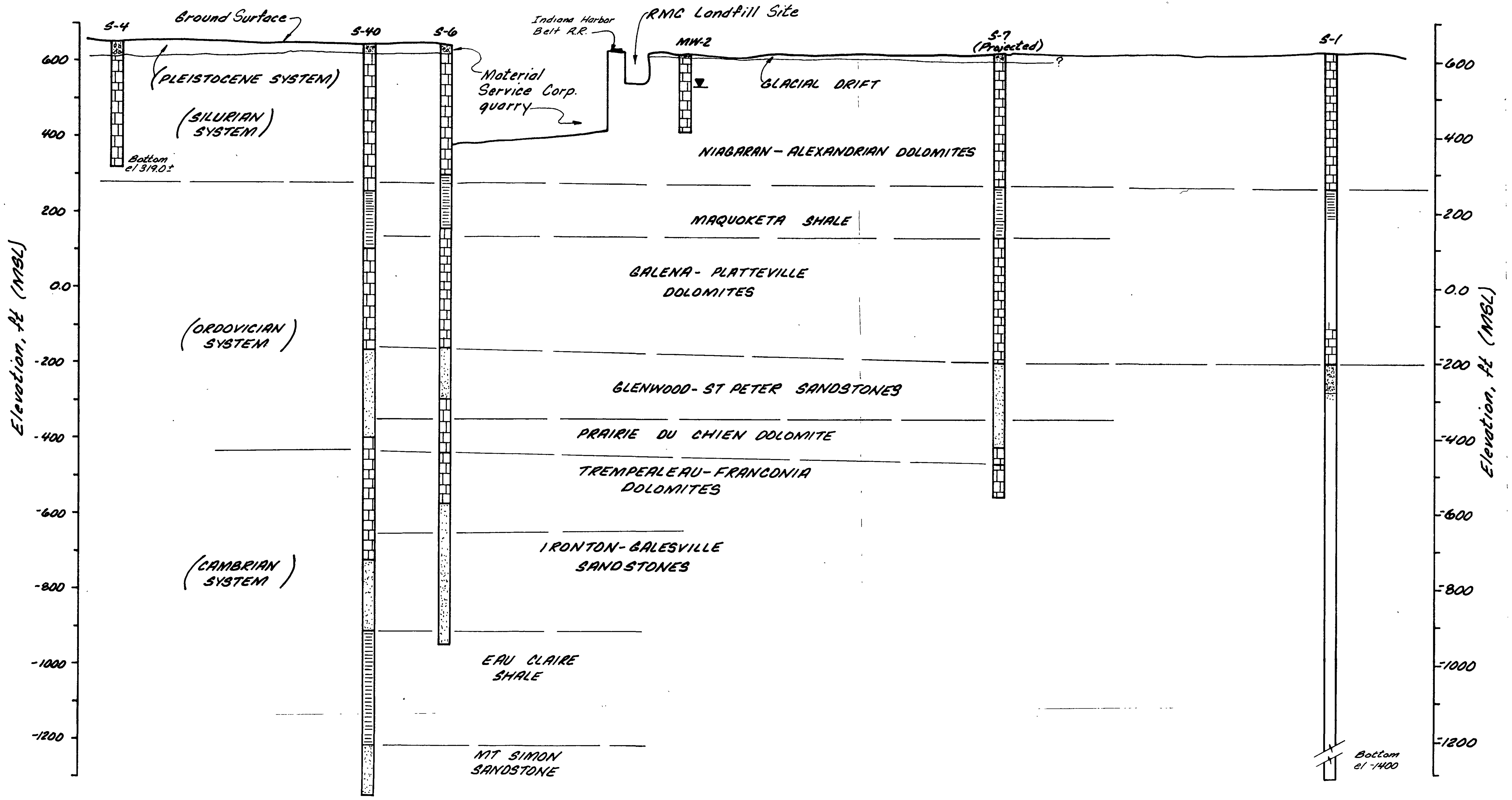
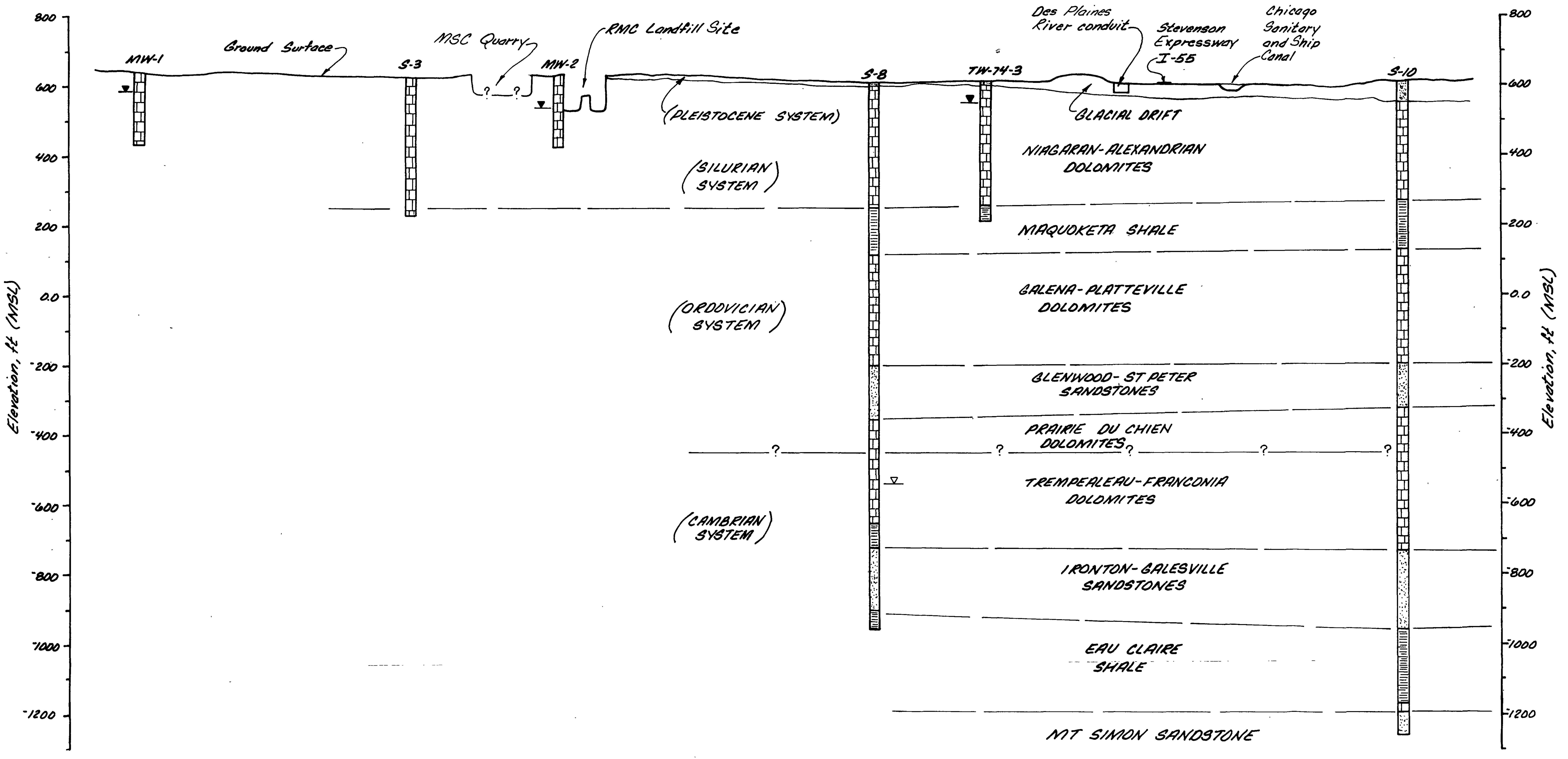
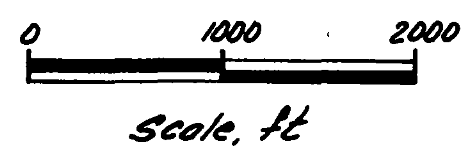


GENERALIZED GEOLOGIC PROFILE A-A

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

DR BY. JVH	CK'D BY: RF
Project NO. Y9C00181	Fig. 2





GENERALIZED GEOLOGIC PROFILE B-B

Woodward-Clyde Consultants Consulting Engineers, Geologists and Environmental Scientists	DR BY JVH CK'D BY RF
Project NO Y9C00181	Fig. 3